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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

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February 9, 1998

VIA HAND DELIVERY

Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
1919 M Street, N.W.
Room 222
Washington, D.C. 20554

Re: Ex Parte Presentation
In the Matter Advanced Television Systems and
Their Impact Upon the Existing Television
Broadcast Service;
MM Docket No. 87-268

Dear Ms. Salas:

This letter notifies the Commission that Mr. Charles Rhodes faxed the attached materials to Mr. Robert Bromery of the Office of Engineering and Technology on February 4, 1998. The materials consist of an advance copy of Mr. Rhodes' April 10, 1998 column in TV Technology, addressing weighted noise power calculations in each channel adjacent to a DTV channel where the spectral power density is as permitted under the FCC's RF emissions mask.

In accordance with the Commission's Rules, two copies of this letter and the attachments are being filed with the Secretary for inclusion in the public record of this proceeding.

Sincerely,

Thomas P. Van Wazer

Thomas P. Van Wazer

Attachment

cc: Robert Bromery

No. of Copies rec'd 0+1
List ABCDE

Charles W. Rhodes
10105 Howell Drive
Upper Marlboro, Md. 20774
Tel: (301) 574 0214
Fax: (301) 574 1978
e-mail: charleswrhodes@worldnet.att.net

Feb 4, 1998

Mr. Robert Bromery
c/o FCC

By Telecopier: (202) 418-1918

Dear Bob:

As you requested, I attach my article, published April 10,1997 in "TV TECHNOLOGY". This shows the total weighted noise power in each channel adjacent to one carrying the DTV signal, where the spectral power density of the sideband splatter is as permitted by the RF Mask.

As you will see in Table 3, Upper Adj. Channel DTV into NTSC, the weighted noise is 2.3 dB above Tov, while for Lower Adjacent channel DTV into NTSC, Table 4 shows that the total weighted noise is 1.8 dB below Tov.

Hence there is a 4 dB difference in the weighted noise power permitted by the RF Mask. This calculation is fully supported by the difference in Tov reported by the ATTC: 11.33 dB vs 7.33 dB.

I have calculated the weighting factor for "white noise" using the weightings vs frequency reported by the ATTC. This gives a weighted noise power of 57.3 dB which is used in Tables 3 & 4. Carl Eilers reported results within 1 dB of this value.

If I may be of any further assistance, please feel free to call me.

Cordially,

Charlie

Charles W. Rhodes

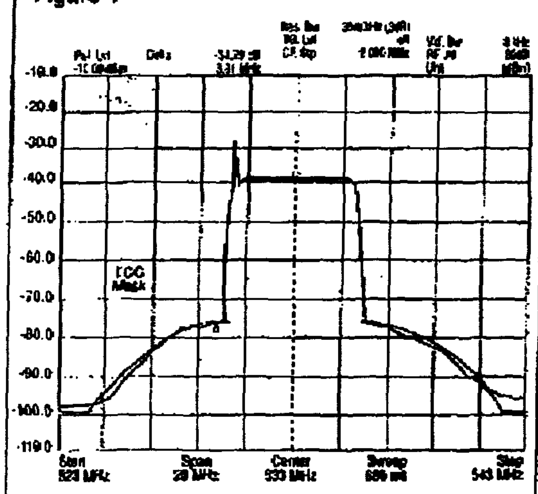
Calculating Weighted Noise

Digital TV

by Charles W. Rhodes

Last month, we left you hanging, wondering how one does weighted noise measurements. Your wait is now over. We will perform a sample calculation

Figure 1



of the weighted noise power in the upper adjacent channel based upon experimental results of the ATTC. Fig. 1 shows the spectral power density of the sideband splatter of an experimental setup at the ATTC compared with the RF mask (splatter limit pro-

power density at each frequency. This is given in Table 2.

The weighted noise power vs. frequency in both adjacent channels is plotted in Fig. 2. As you see, there is more *weighted* power in n+1 than n-1. Looking now in channel n+1, this plot clearly shows that there are two dominant peaks in the *weighted* spectral power density, one at 2.25 MHz and the other at the NTSC color subcarrier.

The first peak is approximately 1 MHz *above* the visual carrier frequency because the visual carrier frequency is nominally 6 dB down on the IF selectivity curve. Signals at 1 MHz above the visual carrier frequency are given 6 dB more gain in the IF amplifier of NTSC receivers.

At a baseband frequency of 1 MHz, the noise weighting is nil, so this is the most sensitive frequency

Table 1: Proposed RF Mask Attenuation vs. Frequency from DTV Channel

F (MHz)	Attenuation (dB)
F = 0	35.00
0.25	35.04
0.75	35.06
1.25	36.09
1.75	37.27

in terms of visually perceived noise. This is luminance noise. Noise near the color subcarrier is demodulated to very low video frequencies (below 500 kHz), for which the weighting factor is nil. This accounts for the second peak at the subcarrier. This noise is chroma noise.

PEAK TO PEAK

Looking again at Fig. 2, this time in channel n-1 we see two peaks again. The chrominance peak is higher than the peak at about 2.25 MHz because there is a much greater noise power density at the subcarrier frequency (which is only 1.17 MHz from the DTV channel edge).

The value of this plot is to show the frequencies at which the sideband splatter needs to be reduced. Clearly, the noise peak at the color subcarrier, 4.83 MHz from the DTV channel boundary, could be readily attenuated with a filter at the output of the transmitter. However the peak 1.17 MHz from the other DTV channel boundary is a much

power is 10 Log 0.5/ 5.38 = - 10.3 dB.

Therefore in 500 kHz the ERP is +14.7 dBk. Now from Table 2 we get the weighting factor for each 500 kHz portion of the NTSC channel and apply that weighting to the power per 500 kHz that the RF Mask would permit in that channel. This is carried out in Table 3.

The weighted Power in dBk at each frequency must be numerically integrated, which cannot be done with logarithmic

Table 2: Weighted Noise Power Spectral Density vs. Frequency in the Upper Adjacent Channel for Proposed RF Mask

E	Attenuation	Weighting	Weighted
0 MHz	35.00 dB	Inf	nil
0.25	35.04	−27.42 dB	−62.46 dB
0.75	35.06	−12.55 dB	−47.61 dB
1.25	36.09	−2.76 dB	−38.85 dB
1.75	37.27	−1.57	−38.84 dB
2.25	38.16	0.00 dB	−38.16 dB
2.75	40.25	−0.83 dB	−41.08 dB
3.25	42.35	−4.11 dB	−46.46 dB
3.75	44.77	−8.91 dB	−53.68 dB
4.25	47.54	−12.15 dB	−59.69 dB
4.83	51.20	−5.77 dB	−56.97 dB
5.41	55.32	−14.37 dB	−69.78 dB
6.00	60.00		

Table 3: Weighted Signal-To-Noise ~~[illegible]~~ n+1 Chart

Assumed NTSC ERP 37 dBK
Assumed DTV ERP 25 dBK (see text)

DTV Power Per 500 KHZ:
−10.3 dB

DTV Power +14.7 dBK

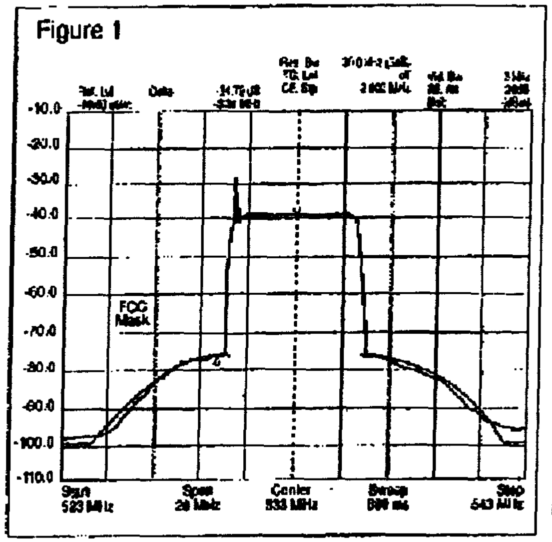
Freq. (MHz)	Wtd. Atten. dB (Table 2)	Wtd. Power (dBK)	Wtd. Power kW
0.25	62.46	−47.76	0.000 017
0.75	47.81	−32.61	0.000 512
1.25 (Fv)	38.85	−24.15	0.003 846
1.75	38.84	−24.14	0.003 855

Calculating Weighted Noise

Digital TV

by Charles W. Rhodes

Last month, we left you hanging, wondering how one does weighted noise measurements. Your wait is now over. We will perform a sample calculation



of the weighted noise power in the upper adjacent channel based upon experimental results of the ATTC. Fig. 1 shows the spectral power density of the sideband splatter of an experimental setup at the ATTC compared with the RF mask (splatter limit proposed in May 1995 by the FCC).

As you see, the actual spectral power density and the RF mask correspond quite well. The two curves digress at very low-noise power levels probably because the noise floor of the spectrum analyzer was being approached. This would not have happened, had the 20 dB of signal attenuation not been switched on. Table 1 gives the attenuation vs. frequency for the proposed RF mask.

The weighting factors (in dB) and these

power density at each frequency. This is given in Table 2.

The weighted noise power vs. frequency in both adjacent channels is plotted in Fig. 2. As you see, there is more *weighted* power in n+1 than n-1. Looking now in channel n+1, this plot clearly shows that there are two dominant peaks in the *weighted* spectral power density, one at 2.25 MHz and the other at the NTSC color subcarrier.

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Table 1: Proposed RF Mask Attenuation vs. Frequency from DTV Channel

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0.25	35.04
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1.25	36.09
1.75	37.27
2.25	38.16
2.75	40.25
3.25	42.35
3.75	44.77
4.25	47.54
4.83	51.20
5.41	55.33
6.00	60.00

Notes: (1) Fv = 1.25 MHz, Fsc = 4.83 MHz and Fa = 5.75 MHz. These are the NTSC carrier frequencies in the Upper Adjacent Channel.

(2) The frequencies selected are those for which ATTC measured Threshold of Visibility, and from which the weighting Factors were thereby determined. This

in terms of visually perceived noise. This is luminance noise. Noise near the color subcarrier is demodulated to very low video frequencies (below 500 kHz), for which the weighting factor is nil. This accounts for the second peak at the subcarrier. This noise is chroma noise.

PEAK TO PEAK

Looking again at Fig. 2, this time in channel n-1 we see two peaks again. The chrominance peak is higher than the peak at about 2.25 MHz because there is a much greater noise power density at the subcarrier frequency (which is only 1.17 MHz from the DTV channel edge).

The value of this plot is to show the frequencies at which the sideband splatter needs to be reduced. Clearly, the noise peak at the color subcarrier, 4.83 MHz from the DTV channel boundary, could be readily attenuated with a filter at the output of the transmitter. However the peak 1.17 MHz from the other DTV channel boundary is a much greater problem for the design and construction of a suitable filter.

The peak at 2.25 MHz from the DTV channel is almost as difficult. Any filter at the transmitter output should introduce very little group delay within the DTV channel, which is an important considera-

power is 10 Log 0.5/5.38 = - 10.3 dB.

Therefore in 500 kHz the ERP is +14.7 dBk. Now from Table 2 we get the weighting factor for each 500 kHz portion of the NTSC channel and apply that weighting to the power per 500 kHz that the RF Mask would permit in that channel. This is carried out in Table 3.

The weighted Power in dBk at each frequency must be numerically integrated, which cannot be done with logarithmic

Table 2: Weighted Noise Power Spectral Density vs. Frequency in the Upper Adjacent Channel for Proposed RF Mask

F	Attenuation	Weighting	Weighted
0 MHz	35.00 dB	Inf	nil
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2.75	40.25	-0.83 dB	-41.08 dB
3.25	42.35	-4.11 dB	-46.46 dB
3.75	44.77	-8.81 dB	-53.58 dB
4.25	47.54	-12.15 dB	-59.69 dB
4.83	51.20	-5.77 dB	-56.97 dB
5.41	55.33	-14.37 dB	-69.70 dB
6.00	60.00		

Table 3: Weighted Signal-To-Noise ~~[illegible]~~ n+1 [illegible]

Assumed NTSC ERP 37 dBK
Assumed DTV ERP 25 dBK (see text)

DTV Power Per 500 KHZ: -10.3 dB

DTV Power +14.7 dBK

Freq. (MHz)	Wtd. Atten. dB (Table 2)	Wtd. Power (dBK)	Wtd. Power kW
0.25	62.46	-47.76	0.000 017
0.75	47.61	-32.91	0.000 512
1.25 (Fv)	38.85	-24.15	0.003 846
1.75	38.84	-24.14	0.003 855
2.25	38.16	-23.46	0.004 508
2.75	41.08	-26.38	0.002 301
3.25	46.46	-31.76	0.000 667
3.75	53.58	-38.88	0.000 129
4.25	59.69	-44.99	0.000 032
4.83 (Fsc)	56.97	-42.27	0.000 059
5.41	69.70	-55.00	0.000 003

Total Weighted Noise Power in (N + 1) 0.015 926 kW -17.98 dBK

Peak NTSC Visual Power 37.0 dBK
Total Weighted Noise Power -17.98 dBK

Signal-to-Weighted Noise (N + 1) 54.98 dB

Threshold of Visibility, Weighted

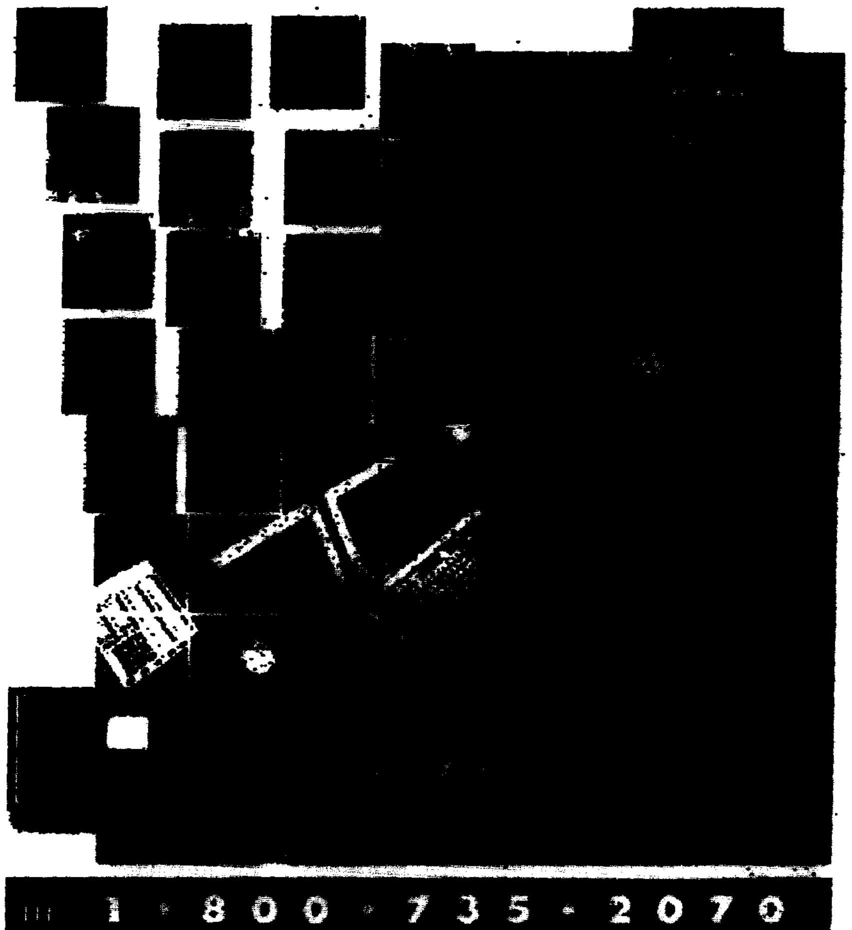
density and the RF mask correspond quite well. The two curves digress at very low-noise power levels probably because the noise floor of the spectrum analyzer was being approached. This would not have happened, had the 20 dB of signal attenuation not been switched on. Table 1 gives the attenuation vs. frequency for the proposed RF mask.

The weighting factors (in dB) and these spectral power density values (also in dB) are added to obtain the weighted spectral

3.75	44.77
4.25	[illegible]
4.83	51.20
5.41	55.33
6.00	60.00

Notes: (1) Fv = 1.25 MHz, Fsc = 4.83 MHz and Fa = 5.75 MHz. These are the NTSC carrier frequencies in the Upper Adjacent Channel.

(2) The frequencies selected are those for which ATTC measured Threshold of Visibility, and from which the weighting Factors were thereby determined. This was discussed in this column January 9th issue, page 36.



of a suitable filter.

The peak at 2.25 MHz from the DTV channel is almost as difficult. Any filter at the transmitter output should introduce very little group delay within the DTV channel, which is an important consideration. Therefore, the peaks at 1.17 and 2.25 MHz from the channel boundary are the more difficult problems for filter designers.

Group delay — not attenuation — is the crucial problem in both cases. Fortunately, the power dissipated in this DTV filter is constant, so the thermal stability of this filter should not be a problem.

Table 2 also provides the data needed to determine whether the FCC-proposed RF mask would be appropriate to ensure that DTV interference from the lower adjacent channel would not be visible on NTSC screens.

To carry out the needed calculation, we must first convert all the weighted noise powers from dB (logarithmic units) to linear units so they can be numerically integrated. Then the integral is converted back to dB.

Perhaps the best way to understand how this calculation is handled is to follow this logic referring to Table 3.

Assume the effective radiated power of the NTSC signal to be protected is 5 MW, or 37 dBk (dB above a kilowatt). Assume further that the average ERP for the DTV signal is 12 dB *less*, which would provide equal coverage (assuming both signals are radiated from the same height above average terrain, HAAT.

So the digital signal has an ERP of 25 dBk. Its spectral power density is constant across its channel for 5.38 MHz. Therefore, in a 500 kHz portion of its channel, the

3.75	53.66	−38.96	0.000 126
4.25	[illegible]	[illegible]	[illegible]
4.83 (Fsc)	58.97	−42.27	0.000 059
5.41	69.78	−53.00	0.000 008
Total Weighted Noise Power in (N + 1)			0.015 926 kW −17.98 dBK
Peak NTSC Visual Power		37.0 dBK	
Total Weighted Noise Power		−17.98 dBK	
Signal-to-Weighted Noise (N + 1)		54.98 dB	
Threshold of Visibility, Weighted Noise in an NTSC channel		57.3 dB	
Noise Margin (N + 1)		− 2.3 dB	CwR

units of power (dBk); so each is converted to kilowatts as shown. These powers are added to integrate all noise powers in the NTSC channel. In Table 3 the sum is 0.015926 kW, or - 17.98 dBk.

Now the bottom line is in sight. The total weighted noise power is - 17.98 dBk, while the peak visual power of the (NTSC) signal is + 37 dBk; so the *weighted* signal-to-noise power ratio is 54.98 dB, or 2.3 dB *above* the threshold of visibility of weighted noise. This proves that noise would be (slightly) visible when the sideband splatter is the maximum permitted under the proposed RF mask.

GOOD NEWS, BAD NEWS

If there is good news, it is that when this computation is applied to the NTSC channel *below* the DTV channel, the total weighted noise is at the threshold of visibility, but not above it.

But the really bad news is that the path loss from the tower to the home is generally not the same for both signals, especially when the HAAT differ. The DTV antenna may have to be below the top of the tower.

If the path loss is greater for the DTV signal than for the NTSC signal, noise would not appear on NTSC screens. But at some locations the reverse may be the case

(See *Noise Margins*, page 34)

ase. Let me explain.

FCC F (50/50) Charts: The most commonly used method for predicting TV station coverage is based on a set of charts in he FCC Rules and Regulations — specifically 73.699, Figures 9 and 10. What many nontechnical TV people do not realize is hat these charts do not state that the signal at a certain distance will be a certain level.

Instead, according to the Rules, "If the 50 percent field strength is defined as that value exceeded for 50 percent of the time, hese F (50/50) charts give the estimated 50 percent field strengths exceeded at 50 percent of the locations . . . ."

In other words, only half the locations, half the time, may receive a signal level equal or greater than that predicted by the coverage map. So, under the best of circumstances, the coverage maps are an approximation of real world coverage.

The FCC warns users of the charts that "under actual conditions, the true coverage may vary greatly from these estimates because the terrain over any specific path s expected to be different from the average terrain on which the field strength charts were based."

The charts determine coverage in a specific direction based on effective radiated power from the antenna in that direction and the height of the transmitting above average terrain in that direction. Height above average terrain is calculated by averaging the elevation between two and 10 miles (3.2 and 16.1 km) from the transmitter site.

This means a large mountain obstruction 11 miles from the transmitter would not be considered in predicting coverage, even though it could have a significant impact on real-world coverage. Another warning applies to UHF stations:

73.683(b) It should be realized that the F (50/50) curves when used for Channels 14-69 are not based on measured data at distances beyond about 48.3 kilometers (30 miles). Theory would indicate that the field strengths for Channels 14-69 should decrease more rapidly with distance beyond the horizon than for Channels 2-6, and modification of the curves for

CONTINUED FROM PAGE 32

Noise Margins

due to pattern differences. The DTV signal received may be less than 12 dB below the NTSC signal, in which case noise would be visible (and it could become quite visible).

So now you know how to take the spectrum plots of the DTV transmitters, and from them, calculate the *weighted total noise power* in the adjacent channel to determine how much noise margin you would have or would not have. Recall that in the example of the proposed RF mask, the noise margin was *negative* by 2.3 dB.

Table 3 is valuable in showing the effect of filtering the DTV transmitter output power. The big contributors to the total *weighted* noise power are 1.25, 1.75 and 2.25 MHz. Remove all noise above 2.5 MHz and the total weighted noise power drops only 1 dB.

If the filter also removes noise below 2.0 MHz, the gain is 2.9 dB, while if the filter removes all noise above 1.5 MHz the gain would be 5.6 dB (but such a filter may not be practical either in terms of its first cost or its group envelope delay, which reduces DTV coverage because of increased intersymbol interference within the radiated DTV signal).

If the range of improvement by filtering the transmitter output is 3 to 6 dB, then some reduction in the unfiltered sideband splatter may also be necessary. In theory, a 2 dB back-off in power output should result in a 4 dB decrease in sideband splatter. In cases where this does not occur, I suspect the sideband splatter didn't fall off per theory because it was generated in the driver — not the HPA that was being backed off.

Table 4 gives the calculation of weighted noise power in the lower adjacent channel for the proposed RF mask. In this case there is a small noise margin, of + 1.8 dB, so the filtering requirements to protect n-1 are less severe than needed to protect n+1 by 4 dB. This can be seen in Fig. 2.

In this issue, we have shown how weighted noise power measurements can be made with a spectrum analyzer and a handheld calculator. We have suggested that this be done where the DTV channel is adjacent to an NTSC channel, especially in the same city; but it is also well-worth doing when the NTSC and DTV coverage areas overlap. ■

Assumed NTSC ERP [illegible]
Assumed DTV ERP 25 d BK (see text)

DTV Power Per 500 KHZ: −10.3 dB

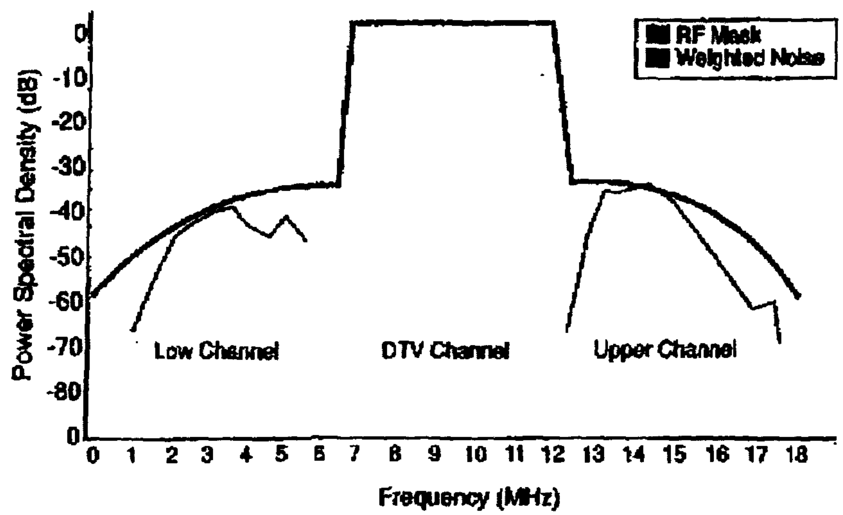
DTV Power +14.7 dBK

Freq. (MHz)	Atten. dB	Wtd. Atten. dB	Wtd. Power (dBK)	Wtd. Power kW
5.75	57.36	[illegible]	-73.59	[illegible]
5.25	54.14	−66.69	−51.99	0.000 006
4.75 (Fv)	50.47	−53.43	−38.73	0.000 134
4.25	47.54	−49.11	−34.41	0.000 362
3.75	44.77	−44.77	−30.07	0.000 984
3.25	42.34	−43.17	−28.47	0.001 422
2.75	40.26	−44.36	−29.66	0.001 081
2.25	38.52	−47.43	−32.73	0.000 533
1.75	37.13	−49.25	−34.55	0.000 351
1.17 (Fsc)	35.95	−41.72	−27.02	0.001 985
0.59	35.24	−49.61	−34.91	0.000 323

Total Weighted Noise Power in (N − 1) 0.006 182 kW −22.09 dBK

Peak NTSC Visual Power	37.0 dBK
Total Weighted Noise Power	−22.09 dBK
Signal-to-Weighted Noise (N + 1)	59.09 dB
Threshold of Visibility, Weighted Noise in an NTSC channel	67.3 dB
Noise Margin (N + 1)	1.8 dB

Figure 2



Charles Rhodes recently completed his tenure as chief scientist for the ATTC, a position he held since 1988. His career includes work for Philips Laboratories, Scientific-Atlanta and Tektronix. In addition, he is a SMPTE and IEEE fellow, and was awarded the David Sarnoff Gold Medal by SMPTE. He can be reached c/o TV Technology.

CO-CHANNEL INTERFERENCE (ATV-to-NTSC)

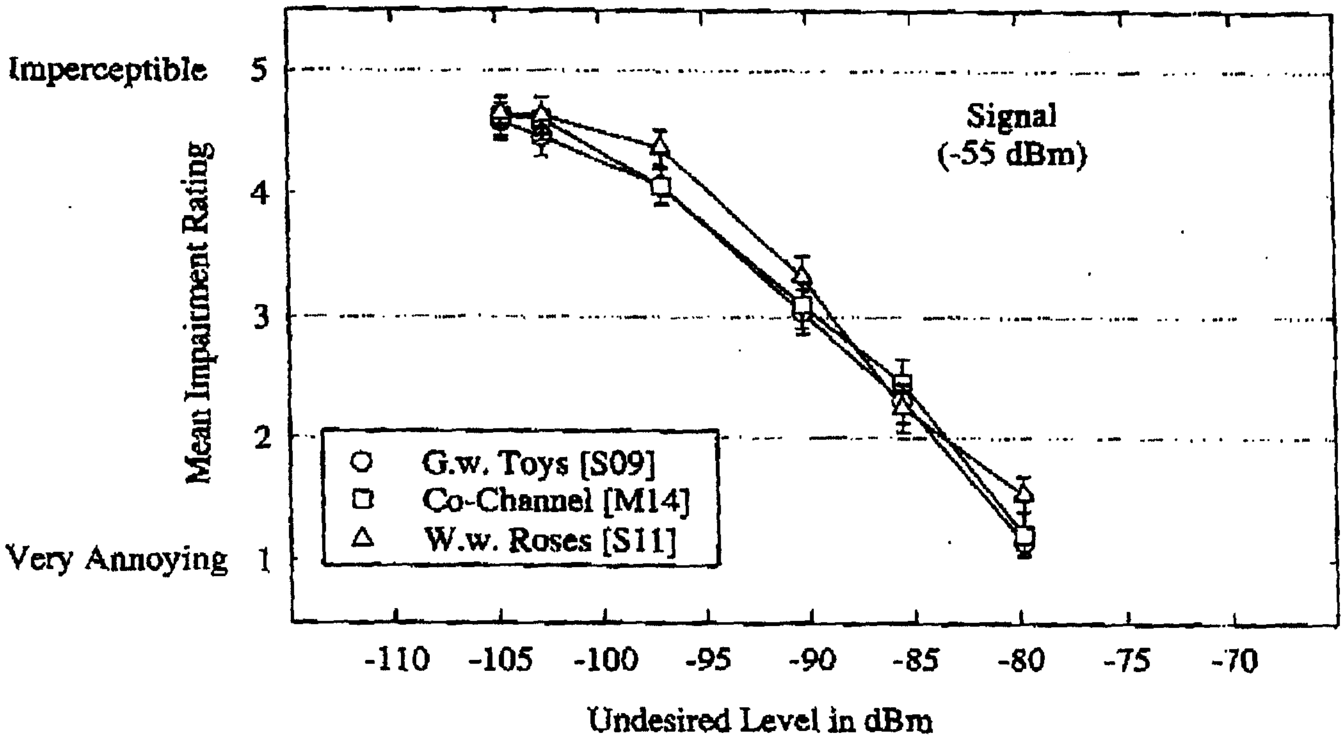


FIGURE 13. Mean impairment ratings for Co-Channel Interference tests for the *digital* Grand Alliance HDTV System.

TABLE 19
CO-CHANNEL INTERFERENCE (ATV-to-NTSC)
PARAMETERS

DESIRED LEVEL	PICTURE	4.0 LEVEL		3.0 LEVEL FOR SPECTRUM PLANNING	
		MEAN RATING	CONFIDENCE INTERVAL	MEAN RATING	CONFIDENCE INTERVAL
SIGNAL -55 dBm (WEAK)	G. w. TOYS (S09)	-96.61	±1.61	-90.00	±1.20
	CO-CHANNEL (M14)	-96.59	±1.54	-89.52	±1.43
	W. w. ROSES (S11)	-94.61	±1.40	-88.81	±0.91
	OVERALL	**-95.94**	**±1.50**	**-89.44**	**±1.18**